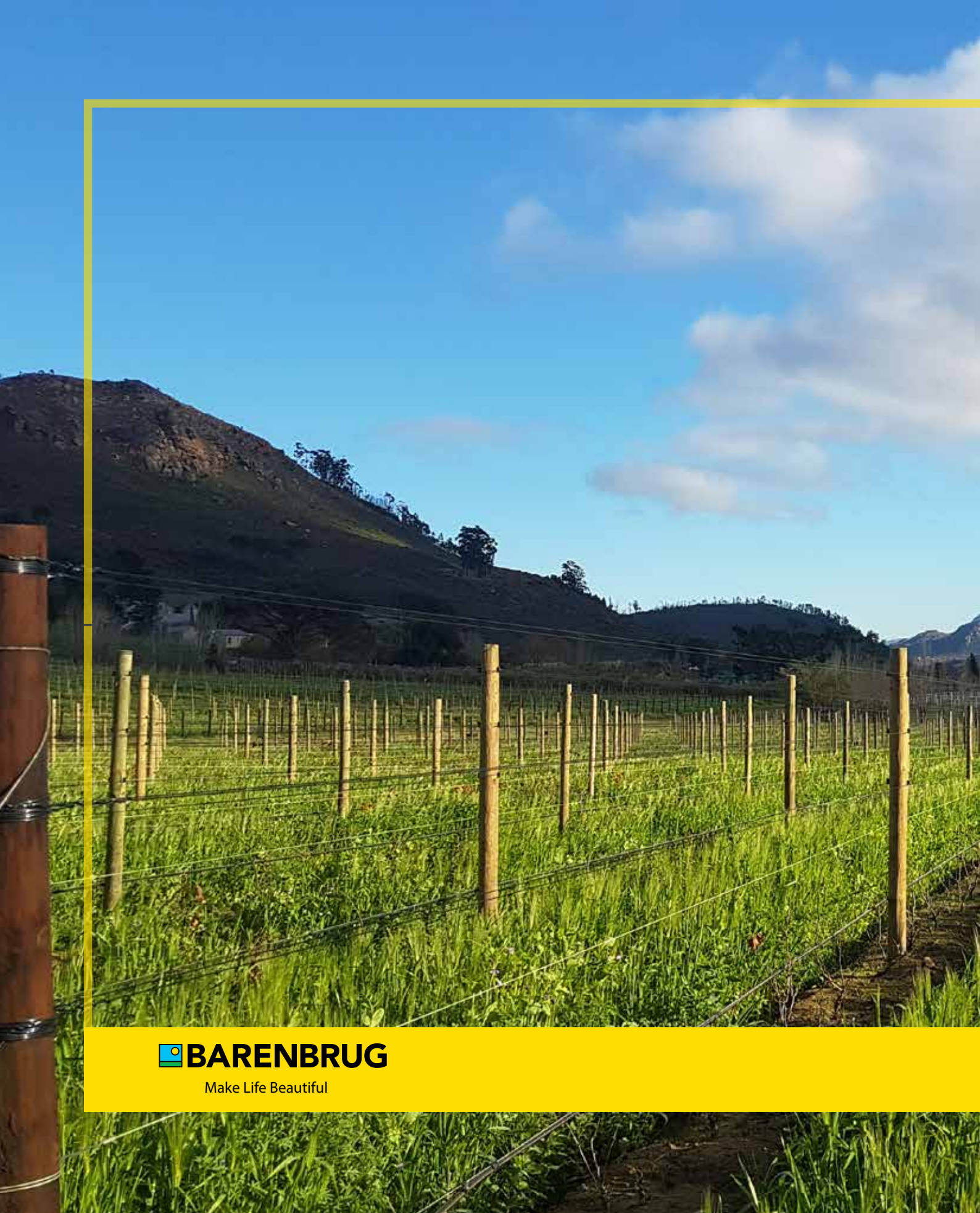
Cover Crop Guide

Second Edition

BARENBRUG



BARENBRUG

Make Life Beautiful

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BARENBRUG

About Barenbrug

Barenbrug specializes in plant breeding, seed production and the international marketing of seeds for pasture cover crops, turf, forage and legumes. Founded in 1904, our company stands for top quality that is appreciated by a global customer network. We put the customer at the heart of our business, making the Barenbrug experience outstanding at every level.

Barenbrug has great confidence in the excellent research that is carried out within our international network of subsidiaries and research facilities in all the important climatic zones. We are certainly one of the leading companies in our field and we strive to be the partner of choice for innovative and sustainable solutions for cover crops, forage and turf. Therefore, we can offer tailored solutions in highly specific, localized cases. Our brand stands for quality and innovation. That is our commitment, our yellow promise.

The fact that the world's population will grow to nine billion within a few decades puts a heavy responsibility on any company that is involved – be it directly or indirectly – in food production, water consumption and CO2 emissions. It is a responsibility that we will respond to and make a significant contribution.

We see cover crops as a tool to give back to our soils which have been intensively cultivated for many years. Cover crops contribute to carbon sequestration, reducing the amount of fertilizers ending up in our water reserves and decreasing harmful chemical inputs, thus increasing soil health. This is our contribution to a better world for generations to follow.

Regenerative Agriculture

South Africa is steadily converting from conventional farming methods to regenerative agriculture (RA). RA systems generate multiple benefits in terms of yield, sustainability of land use, income, timeliness of cropping practices, ease of farming and eco-system services, therefore the area under RA systems has been growing exponentially in many countries.

RA consists of five main principles:

1. Minimum tillage and soil disturbance
2. Permanent organic soil cover (Crop residue, cover crops or mulch)
3. Diversification of crop species (Crop rotation and intercropping)
4. Living roots in the soil as long as possible throughout the year
5. Animal integration (COVERGRAZE™)

Cover crops play a large role in RA practices all around the world. It can contribute to all the principles above. Its roots biologically provide tillage where mechanical tillage is not an option due to minimum tillage being practiced. Therefore, cover crops provide a sustainable alternative to increase infiltration and aeration without damaging the soil in the process. Cover crops can also produce large amounts of biomass that serves as an organic soil cover. Diversity is very important seeing that it stimulates larger microbial populations. Cover crops can also be used to increase diversity of a crop rotation system.

The overuse of chemicals and fertilizers can be very dangerous and can greatly hamper the benefits that RA practices provide. Therefore, it would be wise to use cover crops where possible to fix nitrogen, scavenge for nutrients, suppress weeds and attract natural predators.

Bertie Coetzee - Prieska, Northern Cape

"My favourite mixture is black oats, vetch, red clover and radish. It is very important to me that there is enough forage during high density grazing and sufficient regrowth to provide a lot of biomass into which I can plant maize. The mixture is grazed twice before we allow it to regrow after which we roll it flat before planting maize. Black oats are a good source of fibre and fit well into my maize/cover crop/wheat rotation system. Clovers and vetch fix nitrogen while radishes act as small fertilizer tanks that catch excess nutrients and then releases it during decomposition."

What are Cover Crops?

Cover crops refer to any plant population established to benefit the soil, whether in rotation with cash crops or between the rows of orchards or vines. The main purpose is to protect and enrich soils, leading to better soil health over time. A cover crop is a crop planted primarily to manage soil fertility, soil quality, water, weeds, pests, diseases, biodiversity and wildlife in an agro ecosystem, an ecological system managed and largely shaped by humans across a range of intensities to produce food, feed or fibre (Lu et al. 2000).

Cover crops are of interest in sustainable agriculture as most of them improve the sustainability of agro ecosystem attributes and may also indirectly improve qualities of neighbouring natural ecosystems. Farmers choose to grow and manage specific cover crop types based on their own needs and goals, influenced by the biological, environmental, social, cultural, and economic factors of the food system in which farmers operate (Snapp et al. 2005).

Cover Crop Selection

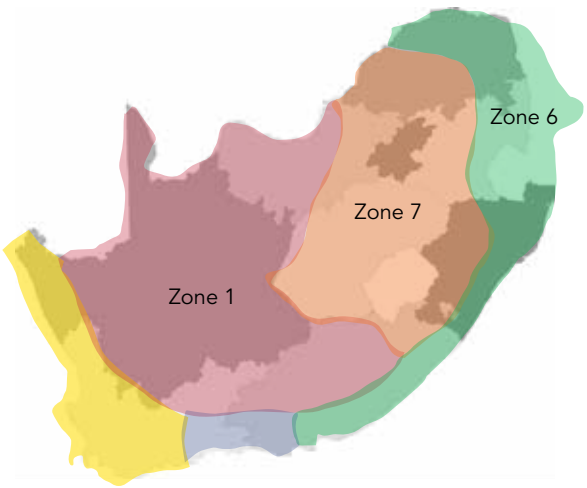
It is important to select the right species and varieties to ensure the best results. There are many species and varieties available, therefore it is extremely important to contact a cover crop specialist to assist you with the selection process. When selecting cover crops, the following factors should be considered:

Climate

The availability of moisture differs throughout South Africa. Generally, the rainfall is greatest in the east and gradually decreases westward with most of the country receiving it in the summer months. The exception is the Western Cape which has a Mediterranean climate receiving most of its rain in winter followed by a dry summer. The coldest days are normally during June to August.

Scan to answer a few quick questions and receive a recommendation for a custom Barenbrug mixture.

Hardiness Zones in South Africa



- Zone 1: Hot arid
- Zone 2: Mediterranean
- Zone 5: Cool subtropical
- Zone 6: Warm subtropical
- Zone 7: Warm semi-arid

Soil type

Some species are very specific to which soil types they prefer, other are widely adapted. A soil analyses is therefore recommended to determine what soil types and structures are present on your farm. Refer to the Cover Crop table on page 26 for the soil preferences of different species.

Goals

When monoculture or mixtures are selected, the end goal and what it is that you would like to achieve must be kept in mind. Here is a list of common goals:

- Weed suppression
- Biomass production
- Nitrogen fixation
- Alleviating compaction
- Erosion control
- Forage production
- Stimulation of microbial activity
- Bio fumigation
- Attracting natural predators and pollinators
- Low maintenance
- Decoration
- Moisture conservation
- Combatting soil disease

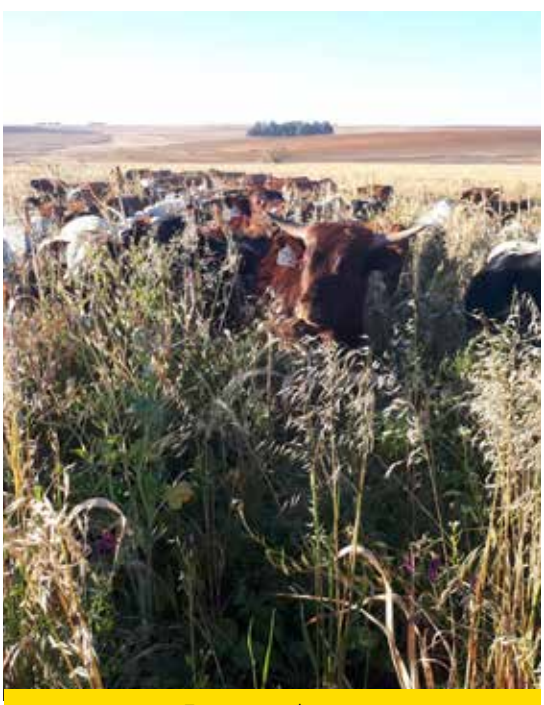
Challenges

Possible challenges should be kept in mind during species/variety selection. This includes:

- Wet soils
- Low or high pH soils
- Saline soils
- Compaction
- Nematodes
- Low rainfall
- Erratic weather patterns
- Soil temperature
- Weeds
- Infrastructure
- Equipment

Considering the above-mentioned during selection will help to achieve the best possible result. It also makes cover crops much more cost effective.

Low maintenance cover crop



Forage production

Management of Cover Crops

Establishment

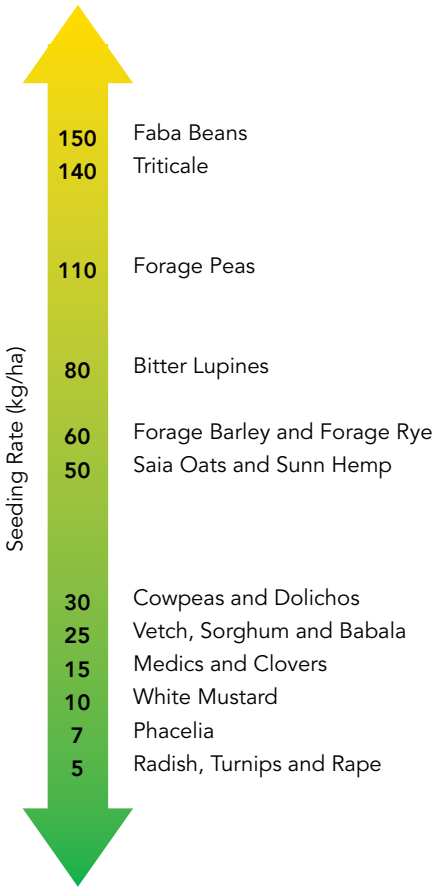
During the planting proses it is very important to make sure that the cover crop seed is placed at the correct and uniform depth to ensure good germination. Therefore, planning should be done well in advance, especially when establishing mixtures. Planting mixtures does come with challenges like different seed sizes, seeding rates and preferred planting depths. Also note that we recommend inoculating legumes before planting. The planting date depends on moisture availability and temperature. Please note that summer growing crops are more sensitive to soil temperatures compared to winter growing crops.

Inoculation

The importance of inoculating legumes

- Rhizobium bacteria are important because they convert nitrogen gas from the atmosphere into a form of nitrogen that is readily used by plants (nitrogen fixation)
- It allows legumes to fix their own nitrogen, allowing it to create more biomass, but also for a better quality (especially protein content) pasture
- As a cover crop where no or only some of the material is removed it can increase nitrogen availability for the follow up crop or perennial crop (vineyards and orchards) already present
- Less inorganic nitrogen needed, reducing soil acidification and nitrogen leaching
- New strains are much more effective and efficient. Natural occurring rhizobium regularly inoculate secondary roots, where if you inoculate with rhizobium, it normally inoculates the primary root, leading to more nitrogen being fixed.
- The cost of inoculants is easily compensated for by all the benefits

Establishment



How to apply liquid inoculants

1. Place the seed on a cement floor, in a mixing container or a cement mixer
2. Pour the inoculant over the seed
3. Mix until all the seed is covered
4. Let it dry for about 1 to 2 hours
5. For the best results, plant the seed preferably on the same day

Nitrogen Fixing Potential of Legumes		
Species	**Potential N (kg/ha) ***	**Value (R/ha) ****
Forage Peas	60 - 105	1 500 - 2 625
Vetch	55 - 170	1 375 - 4 250
Lupines	85 - 130	2 125 – 3 250
Cow Peas	80 - 100	2 000 – 2 500
Perennial Clover	85 - 225	2 125 - 5 625
Annual Clover	80 - 150	2 000 – 3 750
Faba Beans	110 - 170	2 750 - 4 250

* Influenced by various factors. ** Based on R25/kg N (LAN)

Which inoculants to use *(Available at Barenbrug)*

Rizo-Liq Peas & Vetch – Forage peas and faba beans (50kg seed/packet); vetch (25kg seed/packet)
Rizo-Liq Lucerne – Lucerne, barrel medics (truncatula) and sweet clover (melilotus) (25kg seed/packet)
Rizo-Liq Lupins & Serradella – Lupines (50kg seed/packet); serradella (25kg seed/packet)
Rizo-Liq Clover – White-, red-, subterranean- and other clovers (25kg seed/packet)
Rizo-Liq Polymorpha - Burr medics (polymorpha) (25kg seed/packet)
Rizo-Liq Groundnut & Cowpea – Cowpeas, dolichos, sunn hemp, groundnuts, velvet beans, mung beans and pigeon peas (50kg seed/packet)

Fertilization of cover crops

The traditional thinking is to fertilize as little as possible to keep input costs low. However, some fertilizer might give better results making it more cost effective. A soil analysis should preferably be done and the selected species should be kept in mind while determining the fertilizer requirements. Nitrogen fertilization should be kept at a minimum with legumes, seeing that too much freely available Nitrogen could inhibit rhizobium bacteria from fixing nitrogen. Cover crops established mainly for soil conditioning and maximum ground cover will have a lesser effect on the soil nutrient status due to the produced biomass not being removed. Where using cover crops for cut and carry or grazing systems, the opposite might happen. This may require additional fertilizer as the soil should be replenished with certain nutrients before the next crop is established.

Fertilization of cover crops can increase the following:

- Root development
- Biomass production
- Nutritional value (animal production)
- Canopy (groundcover)

Termination

Cover crops are normally terminated to start the decomposition process in a short-term rotational system. There are different ways to terminate cover crops:

- Moldboard plow
- Flail mower
- Disc
- Multi-mulcher
- Roller crimper
- Animals
- Chemically

Rolling is the preferred method of termination. It involves flattening the cover crop to produce a thick, uniform mat of mulch. One action is usually enough, especially with a crimper roller. Certain species however accumulate a higher fibre content over the same growing season, which will necessitate an additional rolling action – preferably in the opposite direction. Cutting, mulching, disking or grazing are also effective ways to manage cover crops. These actions relate to a more drastic termination process. Biomass is either used as animal feed for a quick return on investment or being shredded to contribute to soil quality improvement through quick decomposition by soil microbes.

The appropriate timing and method are often specific to a farming/cropping operation. The optimum termination maturity stage differs between species and varieties of cover crops. The optimum maturity stage normally includes trade-offs among different benefits provided by cover crops. The optimum time to terminate may therefore require balancing of trade-offs. A good example is legumes, when it is allowed to go to its flowering stage it maximizes nitrogen (N) accumulation and pollinator services but flowering for too long can reduce N content in soil as N is transferred to maturing seeds.

The timing termination should also be managed according to the available moisture on a specific piece of land, during a specific season.

- With a dry, early season your lands without living cover crops will be the best option to start establishing your cash crops. Soil will be drier in lands which had a living cover crop during the dry season and will need the first rains for sufficient moisture in the soil profile.
- In a very wet, early season your lands with a living cover crop, will be easier to drill and then terminate the cover crop afterwards.
- In very dry regions, it is also an option to terminate a cover crop in the middle of the rainy season, to conserve moisture for the rest of the season in your soil profile underneath an organic mulch for the next season.

TIP: Use Balansa clover instead of Crimson clover for rolling, its hollow stem terminates easier.

Carbon Sequestration

Cover crops are an important soil carbon sequestration strategy. The roots and shoots of cover crops feed bacteria, fungi, earthworms and other soil organisms, which increases soil carbon levels over time. Years of conventional tillage has led to our soils containing little carbon, therefore it is very important that we use cover crops as a tool to restore our soil carbon levels to what it was before. Organic carbon holds between four and twenty times its own weight of water.

The influence of Carbon on water stored per hectare

Change in soil organic matter	Change in soil organic carbon	Change in available water holding capacity	Change in yield
1.0%	0.58%	3.7%	2.76%
1.5%	0.87%	5.6%	4.14%
2.0%	1.16%	7.4%	5.52%
2.5%	1.45%	9.3%	6.91%
3.0%	1.74%	11.1%	8.29%
3.5%	2.04%	13.0%	9.67%
4.0%	2.33%	14.8%	11.05%
4.5%	2.62%	16.7%	12.43%
5.0%	2.91%	18.5%	13.81%

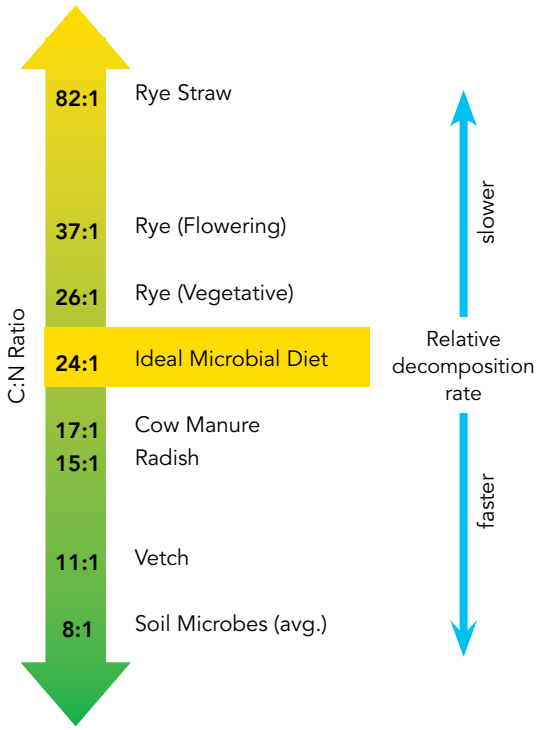
SOM, SOC, AWHC and yield relationships (Blignaut et al. 2015)

Nutrient Cycle

Cover crops are part of nutrient cycles as they take up excess nutrients (predominantly nitrogen) from the previous season and places it in its biomass. When the biomass starts decomposing these nutrients are recycled back into the topsoil, making it easier to be taken up by the follow up cash crops. Some cover crops have deeper roots than cash crops, which allows them to scavenge for nutrients beyond normal rooting depths.

Cover crops differ in how quickly they release nutrients back into the soil. For instance, a rye cover crop would take longer to decompose than vetch, therefore the vetch should release the nutrients back into the soil quicker than rye. However, rye would provide a protective cover for a longer period. While selecting cover crops it is important to keep the carbon to nitrogen ratio (C:N) in mind. C:N ratio indicates the mass of carbon to the mass of nitrogen in a substance. Soil microbes have a C:N ratio of 8:1. Their diet prefers a ratio of 24:1 using 16 parts of carbon for energy and 8 parts for maintenance.

C:N Ratios



The C:N ratio of everything in and on the soil can have a significant effect on decomposition of crop residues. For instance, a cover crop with a very high C:N ratio like rye would take longer to decompose than a cover with a lower ratio like vetch. Therefore, slightly higher C:N ratios are often preferred seeing that it would provide a protective cover for longer, however this may cause a negative N period in your soil. Keep this in mind with early nitrogen applications for the follow-up crop. While it is important to have a lasting soil cover it is also important to have residues that decompose to release nutrients and build organic carbon.

Cover crop mixtures plays a large role in getting the best of both worlds where you can have one component with a high C:N ratio providing cover for long periods and another having a low C:N ratio that releases nutrients back into the soil at earlier stages. Cover crops may increase or decrease N fertilizer needs for the following crop in the rotation. Because decomposition happens quickly, so does plant available nitrogen (PAN) release or immobilization (negative PAN). The amount of PAN released from a cover crop depends on the species and growth stage. Green leafy plant material normally has high N concentrations leading to higher PAN when decomposed. More mature plant material like stems have low N concentrations and low or negative PAN when decomposed.

The C:N ratio controls PAN release. As microbes decompose cover crop residues, a portion of cover crop carbon is lost from the soil as CO2. During the decomposition process the remaining cover crop carbon is transformed to soil organic matter with a C:N ratio of approximately 12:1. Most of this decomposition occurs in the first 4 to 6 weeks of termination. Nitrogen percentage in a cover crop is strongly related to PAN release following cover crop incorporation. For legumes that are high in N, about half of cover crop N is released as PAN because the cover crop has more N than needed to "build" soil organic matter. For non-legumes, such as cereal rye, the release of PAN is small, because most of the cover crop N goes into soil organic matter. When cereal crops reach the heading stage, PAN is immobilized (made negative) by decomposition because more N is required to build soil organic matter than is present in the cereal crop. The PAN of cereals is positive in early vegetative growth but is near zero or negative at flowering. Brassicas however can provide PAN when at flowering growth stage.

Wilhelm Joubert - Stellenbosch, Western Cape

Wilhelm Joubert from Hartenberg established Barenbrug tajuna radish in his vineyards with great success.

Date of establishment: 10 April 2019
Date of photo: 2 September 2019

Soil Health

"95% of life on land resides in the soil and its main source of energy is plant carbon. In exchange for root exudates, microbes in the vicinity of the roots and microbes linked to plants via networks of beneficial fungi increase the availability of minerals and trace elements required to maintain the health and vitality of the plant hosts and provides the glues for soil aggregation, improving soil structure. All living things, above and below the soil, benefit when the plant-microbe bridge is functioning effectively". - *Dr. Christine Jones*

The soil micro biome or soil food web is far more complex than anyone expected and we are still learning as we go.

Beneficial microbes fit into the following groups:

The Recyclers

- Responsible for the breakdown of plant material

Miners (Mycorrhizal fungi)

- Protects plant hosts from pest and diseases and transport nutrients in exchange for liquid carbon

Refiners (Rhizobia)

- Convert nitrogen gas from the atmosphere into a form of nitrogen that is readily available to plants

How do you achieve soil health? You diversify!

A diverse mixture of cover crops provide a balanced diet for microbes through a unique process where plant species exudates chemical compounds through its roots. A greater diversity of plants leads to a greater diversity of microbes and a more robust soil ecosystem. For this reason, Barenbrug has more than 80 different cover crop species and more than 140 varieties available to help create this robust soil ecosystem!

The leaf area index (LAI) of diverse cover crop mixtures are normally higher due to better utilization of space with different growth habits. This leads to more photosynthetic products being transported into the soil, therefore accommodating more microbes compared to monoculture cover crops. This also benefits mycorrhizal fungi seeing that it cannot feed itself and depends on plants for carbon/sugar. Mycorrhizal fungi are very efficient at finding minerals that will help plants in return.

Some of the main soil health benefits that cover crops provide:

Organic carbon

Microbial activity

Aeration and infiltration

Nitrogen fixation

Weed suppression

Erosion prevention

Building structure

Soil moisture conservation

Combatting soil disease

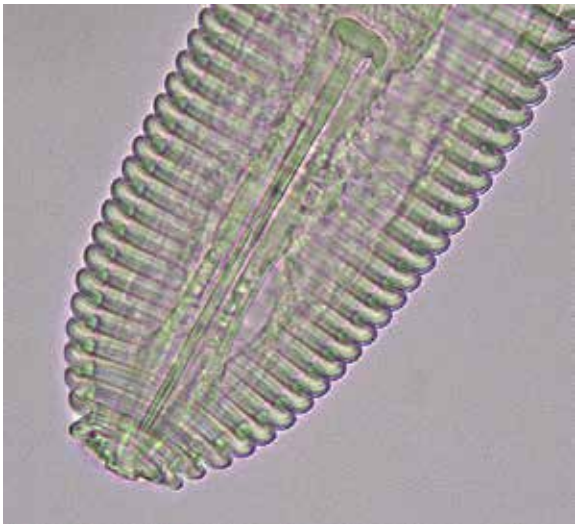
Nematodes

Plant parasitic nematodes (PPN) are microscopically small, unsegmented organisms that vary in length between 0.1 to 1mm. Although they are microscopic in size, these pathogens can have a negative influence on the health of a large variety of agricultural crops. PPN feed on plant roots and lower parts of the plant stem. These damaged roots are less able to absorb much needed water and nutrients (Sheila Storey, Nemlab).

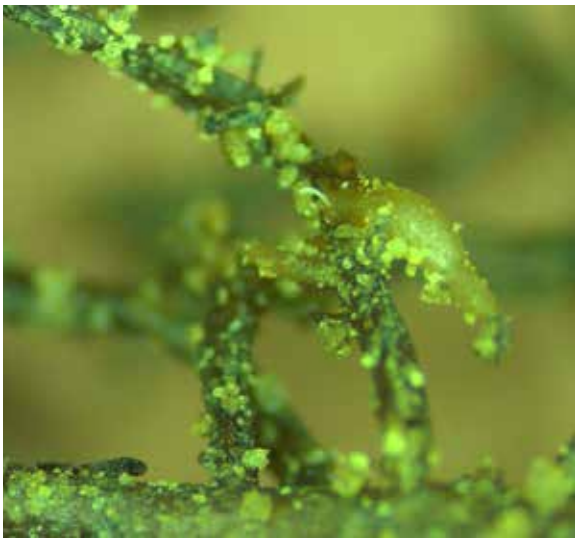
Cover crops can be used to manage and control the amount of PPN present in our soils. By establishing cover crop mixtures, we can stimulate a more diverse microbial population due to different microbes being present on the roots of different cover crop species. By doing this you can increase the chances of the beneficial population competing and some of it even directly feeding on pathogens. If you have a monoculture system your chances of one specie dominating are much bigger.

For a long time, nematodes have been underestimated and little was known about the different species present in our soils. It is very important to know which nematode species are present in your soil. It can allow you to make more informed decisions in terms of which cover crops would be best to try and lower your numbers. What further complicates it is the fact that the host status for PPN differs between species and varieties of crops as well as between different species of nematodes. By knowing which nematodes are present in your soil we can establish cover crops that are non- or poor hosts with the aim of lowering numbers over time. Some cover crops like white and brown mustard are used for bio fumigation of plant parasitic nematodes. The plants produce volatile compounds, of which glucosinolates are the most important. However, the success largely relies on the following:

- The material should be finely chopped/shredded, at the correct growth stage and should then be cultivated into the soil. After this process the plant material will start decomposing and will eventually release the bio-fumigation gasses.
- It should be washed in with water (irrigation or rain). This will effectively transfer the gasses into the soil and seal the surface.
- The pH of the soil should be corrected.



Source: Nemlab, AP Malan



Source: Nemlab

Source: Nemlab

COVERGRAZE™

"The beef community use a technology that produces high quality protein from solar energy locked within human inedible plants. This technology produces a natural organic fertilizer and is mobile without using fossil fuels. This technology self-replicates. The technology is cattle. Beef is the original plant-based meat" – Dr Sara Place

Barenbrug's COVERGRAZE™ mixtures provide the solution to farmers that want to produce forage for their livestock and simultaneously look after their soil health. For years it was recommended that farmers should keep their animals off cash crop lands, but with COVERGRAZE™ this way of thinking has changed. Utilizing cover crops with animals present the opportunity to generate an income and not only improve your soil biology. The correct utilization of cover crops, with high producing animals in the summer rainfall areas, have regularly shown to be more profitable than the normal cash crop options.

The management of grazing intensity and intervals is of the utmost importance. Therefore, farmers often move their herd on a daily basis under an ultra-high stock density (UHSD) grazing system. With this system they replicate the grazing habits of large herds in nature and prevent compaction due to the limited time that the animals spend in one camp. The hoof action, manure, urine, saliva and even the CO_2 emissions of the herd is beneficial for microbes and plays a big role in the build-up of organic matter in our soils. It should be kept in mind that providing enough drinking water is one of the biggest challenges of these UHDG systems seeing that the livestock are moved regularly. Many creative solutions have presented itself to overcome this challenge.

With the help of your Barenbrug agronomist, COVERGRAZE™ mixtures can provide a complete fodder flow program tailor-made for your farm. This can ensure available pasture throughout the year in the form of green feed or standing hay. The idea is to establish species that will provide the highest amount of material of the best quality for a specific utilisation period. The growth period of different varieties and their potential regrowth must be kept in mind. The type of animal that will be utilizing the COVERGRAZE™ mixture also determines the species and variety best suited.

Gert Jv Rensburg - Brits, North West

"We see soil life return in a relatively short period of time, which means we can cut back our fertilizer fairly quickly while the yield and quality improve. By utilizing it with my cattle we increase the working even further. After what we have seen for the last 3 years we are very excited about the role that mixed cover crops can play in our sustainability, profitability and competitiveness."

In most circumstances it is advised to manage your COVERGRAZE™ mixture for regrowth. Normally this is achieved by grazing the cover crop before the main component of the mixture goes into a reproductive growth stage and not grazing it past the desired post grazing residual. A good rule of thumb is to move your animals before you can see their hooves. By doing this enough of the "factory" is left behind for photosynthesis to enable quick regrowth for the next grazing.

The idea is to graze the "cream" of the crop with UHDG and then move the herd. There is some species and varieties that can endure severe grazing better than others like Pearler hybrid millet and annual ryegrass. Always remember that root reserves are depleted with heavy grazing, and it may take 2-3 weeks for regrowth to commence. This can give weeds the opportunity to present themselves. Herds can also be used to control weeds, terminate cover crops and even to establish cover crops with their trampling action.

Barenbrug is proud to offer COVERGRAZE™ specific products for cover cropping. Not only are these products perfect for non-grazing cover crop systems, they also offer superior forage production, digestibility and quality for grazing animals. If COVERGRAZE™ is part of your cover crop plan, choose Barenbrug products for performance that matches your needs.

Scan for COVERGRAZE™ video

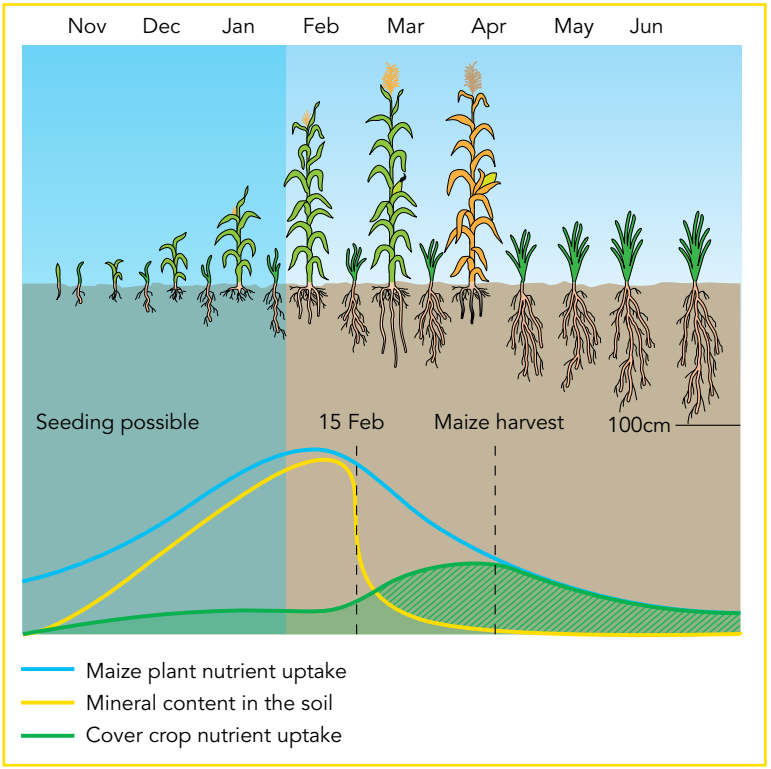
Cover crop periodic table

COOL SEASON PLANTS						WARM SEASON PLANTS		
GRASS							GRASS	
Ryegrass	BROADLEAF PLANTS							
Barley								
Saia Oats	Canola	LEGUMES					Buckwheat	Pearl Millet
Forage Rye	White Mustard	Turnip	Forage Peas	Red Clover	Medic	Sweet Clover	Chicory	Forage Sorghum
Forage Rye	Cilantro	Forage Rape	Biserrula	White Clover	Lucerne	Sunn Hemp	Flax	Sweet Sorghum
Triticale	Phacelia	Beet	Serradella	Crimson Clover	Faba Beans	Dolichos	Safflower	Teff
Forage Oats	Brown Mustard	Forage Radish	Vetch	Sainfoin	Lupin	Cowpea	Turnip	Hybrid Millet

Intercropping

Intercropping is the establishment of a second crop, or cover crop(s), on a field where the previous crop is not removed yet. This is a new concept for most farmers, but something that is possible even in our challenging climatic conditions. For the simple reason that very little moisture is available at harvest of maize, it has become increasingly popular to establish the second crop during the maize's growing season. This allows the second/cover crop to utilize the moisture while it is available. For a cover crop to be able to grow with maize it should comply with the following rules:

- The cover crop species should be able to germinate and survive during the planned seeding date
- The cover crops should not excessively compete with the cash crop for moisture and nutrients
- The cover crop species should be able to survive in the shade of the maize until the maize starts to dry and then be able to utilize the available sunlight and moisture (normally March until May) to ensure enough growth
- It is also favourable if the cover crop can provide a living root through winter and provide quality grazing for livestock during winter



Factors that determine the success of intercropping:

- Method of establishment (planter vs. spreader)
- Soil coverage during establishment
- Seed sizes of cover crops
- Available sunlight (growth stage, row width and stance of maize)

Maize intercropping

Cover Crops Grown in Orchards and Vineyards

Cover crops have been grown between other crops for quite a while. These crops include vineyards, fruit trees, nut trees, vegetables, herbs, etc. Cover crops in vineyards and orchards can stabilize the soil structure, improve water infiltration, suppress weeds, reduce compaction and produce a mat of mulch that reduce evaporation. With all of these benefits it would be senseless to farm with "naked" soil where undesired plants are mechanically or chemically maintained.

Cover crops can be used as a sustainable solution to many of our challenges and can be seen as a practice that will ensure that our agricultural land will be preserved for our descendants. However, it is important to remember that cover crops are not a quick solution to all our problems. Planning is important and it may take time to get the expected result.

Cover Crops for Specific Purposes

Since cover crops have different functions, it is important to determine what the crop is expected to do. Is the intent to add organic matter to the soil? Perhaps to add nitrogen to the cropping system? To stimulate soil biological activity? Or to protect the soil during the winter months?

Cover crops for weed suppression

The main purpose is to suppress weeds in a natural way. Several cover crops are considered "smother" crops because they are used to control or suppress weeds. Crops that give the best results are those that are quick to germinate, provide rapid ground cover and form dense canopies.

- Vetch
- Saia Oats
- White Mustard
- Teff
- Phacelia
- Forage Rye
- Jap millet
- Forage barley
- Radish

Nitrogen fixing cover crops

The main purpose is soil improvement through nitrogen fixation. Legumes such as lupines, clovers, vetch and cow peas that can fix atmospheric nitrogen, are also able to supply nitrogen to subsequent crops. When sources of manure or compost are not readily available, legume crops can be inserted into a crop rotation to supply nitrogen to the cash crops.

Nitrogen fixing legume crops must be inoculated with rhizobium bacteria before planting (see inoculation guidelines). Legume crops require specific strains of fresh or well-preserved inoculants. Inoculation is particularly important if the legume crop has never previously been grown on the site. Also take note that legumes have different growth habits, especially when used in mixtures. Some are creepers and others have a prostrate growth habit.

- Lupines
- Vetch
- Medics
- Serradella
- Clovers
- Faba Beans
- Forage Peas
- Cowpeas
- Sunn Hemp
- Dolichos (Lablab)

Barpower and Haymaker mixture

Kardinal Crimson Clover

Low maintenance cover crops

Turf type grasses are popular cover crops used in orchards due to the low maintenance requirement. These grasses usually form a uniform surface that provides good ground cover as well as weed suppression. Although the idea is to help prevent soil erosion and waterlogging, suppress weeds and provide a good ground cover, the popularity remains the fact that it is a very persistent cover crop that requires little maintenance.

- RTF Fescue
- Creeping Red Fescue
- Paspalum notatum
- Durana - White Clover

Rhizomatous Tall Fescue (RTF)

Bio fumigation and non-host cover crops

To interrupt pest life cycles, it is important to select cover crops of a different family than that of the future cash crops so that they do not harbour pests or diseases that can negatively impact the following cash crops. Some cover crops can perform bio fumigation if it is chopped up and worked into the soil, other crops serve as non-hosts. The host status differs between species and varieties for different pathogens and diseases.

- White Mustard
- Saia Oats
- Brown Mustard
- Sunn Hemp
- Rhodes Grass
- Marigold

Sito White Mustard

Cover crops for mulches

The properties of the cover crop residues are very important as they have a direct influence on the outcome of organic matter decomposition (humification and mineralization) and other plant nutrition dynamics. Young and succulent green manure crops with a low C:N ratio will feed soil micro-organisms, while a mature, fibrous green manure crop such as cereal straw will form stable organic matter but provide less stimulation of soil biological activity.

- Saia Oats
- Forage Rye
- Triticale
- Forage Barley
- Forage Sorghum
- Pearl Millet (babala)
- Rhodes Grass
- Panicum maximum
- Eragrostis curvula

Saia Oats and Haymaker Vetch

Decorative cover crops

The right cover crop can even look decorative among other ornamental plants. Crimson clover is a good example, with its blossoms clustered tightly on upright stalks like strawberry popsicles, that you would hardly suspect that it was improving the soil.

- Crimson Clover
- Sunflower
- Phacelia
- Marigold
- Flax

Flowering Cover Crops

Cover crops for soil improvement

The main purpose is to improve soil structure. Factors to address:

1. Soil aeration
2. Organic matter
3. Soil microbe activity

Cover crops with large taproots or bulbs can penetrate the soil, breaking up compacted layers. In the proses it can increase infiltration and aeration. This is not limited to these species seeing that all root types can aid in this process.

- Radish
- Turnips
- Mustards
- Lupines
- Forage Sorghum
- Annual Ryegrass
- Sunflower
- Rape

Tajuna Radish

Cover crops for waterlogged areas

Faba beans tolerate waterlogged conditions better than other grain legumes such as field peas and lupines. Other options include:

- RTF Fescue
- Paspalum notatum
- Balansa Clover
- Birdsfoot Trefoil
- Tall Fescue

Fiesta Faba Beans

Natural predators and beneficial insects

Predators, parasitic wasps and bees benefit from nectar and pollen provided by flowering cover crops. Differences in flower morphology, such as shape, size and colour, will influence the type of beneficial insects attracted to it.

- Flat, open flowers – pollen and nectar available to all shape and sizes of bees and predators
- Narrow, closed flowers – difficult for small bees and parasitic wasps to enter and obtain nectar and pollen A variety of flower morphologies provide resources to a diversity of beneficial insects. For example:

- Buckwheat
- Phacelia
- Radish
- Mustards
- Canola
- Sunflower
- Lucerne
- Marigold
- Zinnias
- Cilantro
- Flax

Phacelia

Living mulch on plant rows

Cover crops can be established as a living mulch on the berms ('bankies') and work rows of permanent crops. For many years cover crops were only established in work rows seeing that it was difficult to establish cover crops on plant rows. The challenges of establishing cover crops on plant rows are:

- Method of establishment
- It should not compete too much (water and nutrients)
- Growth height limitations

Keeping these challenges in mind we have selected cover crops and techniques that overcome them all. The availability of soil moisture would determine if the cover crop should be annual or perennial. If the cover crop is an annual it is important that it has the ability to reseed itself the next year, otherwise you would have to establish it year after year. Excellent options (especially in the winter rainfall regions) are medics and subterranean clover. It can be established during early autumn before the first rain arrives with the help of drip or micro irrigation. Medics work well in this regard by aggressively spreading its stolons, therefore, even if only sown underneath the drippers it could still cover the berm.

Where sufficient moisture is present, perennial options like white clover perform very well and provide year-round cover. White clover has a low growing and creeping growth habit and spreads with stolons.

Establishing cover crops as a living mulch on the plant rows of orchards and vineyards can provide many additional benefits:

- Weed suppression – reducing herbicide usage
- Nitrogen fixation in the root zone of the permanent crop – reducing inorganic N requirement
- Provides a mulch/cover (decreases evapotranspiration)
- Moving away from monoculture

Some of the species fit for plant rows:

- Medics
- White Clover
- Pinto Peanut
- Sub Clover
- Vetch (with care)

Medics on plant rows

Cover created by Medics

Durana White Clover

Cover Crop Rotation

Cover crop rotation is just as important as rotational systems within cash crop productions. Rotation is particularly important where cover crops are planted between perennial plants, like orchards and vineyards. The reason is that most cash crop systems already make use of short-term rotation systems, but perennial plants are there for very long periods (often 15-25 years). Without cover crops we expose our soils to longer periods of monoculture, which could have a detrimental effect on our soil.

Rotation has the following benefits:

- Better performance of the cover crops
- Less disease and pests
- Address different problems each year
- Increases diversity in our soils

Rotating Cover Crops

Cover Crop Challenges

The use of cover crops is not without some potential challenges. Many annual cover crops must be mowed before they produce viable seeds which could become weeds. Some cover crops have allelopathic properties that can have negative effects on the cash crops that follow. Large amounts of cover crop residues can cause significant problems during seeding of the next crop. Precision planters are particularly sensitive to seedbed conditions with excessive crop residues. Nitrogen can be tied up during decomposition of incorporated fibrous plant material to the detriment of the cash crop. Poorly selected cover crops can attract, stimulate or harbour pests that can negatively impact the following cash crop. Some cover crops can benefit pests that could have a negative effect on the current or follow-up crops. Therefore, it is very important to consult a Barenbrug technical advisor during your selection process.

Cover Crop Summary

	Specie/Variety	Seeding depth (cm)	Seed count (seeds/kg)	Seeding rate (kg/ha)	Optimum pH range	Soil types
Grasses & Grains	Turfsaver RTF	0.5 - 1.5	±420 000	20-30	6.5-8.0	Loam to heavy clay
	Maximus Annual Ryegrass	0.5 - 1.5	± 215 000	20-30	5.0-8.0	Sandy to clay
	Barsaia Saia Oats	1-3	± 53 000	40-50	4.0-8.5	Loam to heavy clay
	Wizzard Forage Oats	2-3	± 43 000	50-60	4.5-8.0	Loam to heavy clay
	Moby Forage Barley	2-3	± 36 000	60-70	6.0-8.5	Loam to clay, well-drained
	Barforce Silage Barley	2-3	± 19 000	60-70	6.0-8.5	Loam to clay, well-drained
	US 2014 Triticale	1-3	± 28 000	120-140	5.0-7.0	Loam to clay, well-drained
	Barpower Forage Rye	1-3	± 55 000	50-60	5.0-7.0	Loam to clay, well-drained
	Barsweet Sweet Sorghum	2-3	± 41 000	15-20	6.0-8.5	Fertile, well-drained
	Bargrazer Forage Sorghum	2-3	± 49 000	20-25	6.0-8.5	Fertile, well-drained
	Pealer Hybrid Millet	1-2	± 82 000	5-15	5.0-7.5	Sandy to clay
	Common Babala	1-3	± 60 000	15-25	5.0-7.5	Sandy to clay
	Tiffany Teff	<0.7	± 4 179 000	15-25	4.5-8.0	Sandy to clay
Legumes	Scimitar Medics	<1	± 299 000	10-15	5.5-8.0	Loam to clay
	Emena Serradella	1-2	± 352 000	15-25	4.0-7.0	Sandy
	Kardinal Crimson Clover	<1	± 266 000	10-15	4.8-8.2	Loam to clay, well-drained
	Dalkeith Sub Clover	<1	± 120 000	10-15	5.0-7.0	Sandy to clay
	Durana White Clover	<0.7	± 1 463 000	6-10	4.5-8.0	Loam to clay
	Barduro Red Clover	<1	± 491 000	8-12	5.8-7.5	Loam to clay
	Haymaker Woolypod Vetch	1-2	± 33 000	15-25	5.0-7.0	Sandy to loam, well-drained
	Morava Common Vetch	1-2	± 15 000	20-30	4.5-8.2	Sandy to loam, well-drained
	Lucerne	1-2	± 392 000	18-30	5.5-7.5	Loam to clay, well-drained
	Fiesta Faba Beans	4-5	± 2 000	130-150	5.0-8.0	Loam to clay, tolerates waterlogging
	Azuro Bitter Lupines	2-3	± 8 000	50-80	5.0-6.5	Sandy to loam
	Arvika Forage Peas	2-4	± 5 000	100-120	5.5-7.0	Loam to clay, well-drained
	Gambit Grain Peas	2-4	± 5 000	100-120	5.5-7.0	Loam to clay, well-drained
	Birdsfoot Trefoil	<1	± 832 000	6-10	6.2-6.5	Adapted to acid and waterlogged soils
	Sainfoin	1-2	± 52 500	65-90	5.5-7.0	Loam to clay, well-drained
	Sweet Clover	1-2	± 622 000	9-12	5.6-8.2	Sandy to clay, not alkaline
	Sunhemp	1-3	± 91 000	40-50	5.0-7.5	Sandy to loam
	Bech White Cowpeas	2-3	± 17 000	20-25	5.6-6.5	Loam, well-drained
	Highworth Dolichos	3-4	± 6 000	20-30	5.5-7.0	Sandy to heavy clay, tolerates acidity
	Pinto Peanut	2-4	± 7 000	8-20	4.5-7.0	Sandy to clay, moist
Brassicas & Herbs	Barkant Turnip	0.5-1.5	± 400 000	2-5	5.5-7.0	Loam to clay
	MPT Turnip	0.5-1.5	± 400 000	2-5	5.5-7.0	Loam to clay
	Cordoba Fodder Radish	1-2	± 56 000	2-5	5.5-7.5	Sandy to clay
	Nooitgedacht Japanese Radish	1-2	± 56 000	2-5	5.5-7.5	Sandy to clay
	Daikon Tiller Radish	1-2	± 56 000	2-5	5.5-7.5	Sandy to clay
	Interval Forage Rape	0.5-1.5	± 261 000	4-5	5.5-8.0	Sandy to clay
	Canola	1-2	± 498 000	2-3	5.5-7.0	Loam to clay
	Commander Chicory	0.5-1.5	± 712 000	6-8	5.0-7.2	Fertile, well-drained
	Captain Plantain	0.5-1.5	± 759 000	8-10	4.2-7.8	Free draining soil
Forbs & Other Broadleaves	Stala Phacelia	1-3	± 550 000	5-8	6.0-7.5	Loam to clay
	Venice White Mustard	1-2	± 218 000	8-10	5.5-8.0	Loam to clay
	Scala Brown Mustard	1-2	± 424 000	7-12	5.5-8.0	Loam to clay
	Flax	1-2	± 266 000	50-60	6.0-7.5	Loam to clay, well-drained
	Buckwheat	2-4	± 48 000	40-50	5.0-8.0	Sandy to loam, well-drained
	Cilantro (Coriander)	0.5-1.5	± 100 000	40-50	6.2-6.8	Sandy to loam
	Marigold	<1	± 320 000	2.5-3	5.5-7.0	Sandy to loam
	Sunflower	2-3	± 23 000	5	6.0-7.5	Sandy to clay
	Zinnias	<1	± 125 000	2.5-3	5.5-7.5	Sandy to loam, well-drained

Rhizobium needed	Growth habit	Growth duration	Growing season	Forage potential	Pollinator Value
N/A	Short, dense	Perennial	W/S	Not suitable	N/A
N/A	Short, dense	Long	W	High	N/A
N/A	Medium, dense	Medium	W/S	High	N/A
N/A	Medium, dense	Medium to long	W	High	N/A
N/A	Short, dense	Short	W	Medium-High	N/A
N/A	Short, dense	Short	W	Medium	N/A
N/A	Medium, upright	Medium	W	High	N/A
N/A	Medium, upright	Medium	W	High	N/A
N/A	Tall, upright	Long	S	High	N/A
N/A	Tall, upright	Medium	S	High	N/A
N/A	Medium to tall, dense	Long	S	Excellent	N/A
N/A	Tall, upright	Short-medium	S	Medium-High	N/A
N/A	Short, dense	Short	S	Medium-High	N/A
Polymorpha	Creeping, dense	Long	W	High	Low
Lupine and serradella	Short, dense	Long	W	Low	Moderate
Clover	Short, dense	Long	W	Medium	High
Clover	Creeping, dense	Long	W	High	Low
Clover	Creeping, very dense	Perennial	W	Low	Excellent
Clover	Medium, creeping	Short-lived perennial	W/S	Low-Medium	High
Peas and vetch	Creeping	Long	W/S	Medium	High
Peas and vetch	Short, dense	Medium	W	Medium	High
Lucerne	Medium, bush type	Perennial	W/S	High	Excellent
Peas and vetch	Medium, upright	Medium	W	Medium	Low
Lupine and serradella	Medium, upright	Medium	W	Medium	Moderate
Peas and vetch	Medium, upright	Medium	W/S	Medium	Low
Peas and vetch	Medium, upright	Short	W	Low-Medium	Low
Lotus	Creeping	Perennial	W/S	Medium	Moderate
-	Medium, dense	Perennial	W	Medium	Excellent
Lucerne	Medium, bush type	Long	S	Medium	Excellent
Groundnut and cowpeas	High, upright	Medium	S	Medium-High	Moderate
Groundnut and cowpeas	Creeping	Medium	S	Medium-High	High
Groundnut and cowpeas	Creeping	Long	S	Medium-High	High
-	Creeping, dense	Perennial	W/S	Medium-High	Moderate
N/A	Short, dense	Medium	S	Medium	Low
N/A	Short, dense	Medium - long	W	High	Low
N/A	Medium, dense	Medium	W	Medium	High
N/A	Short, dense	Medium	W/S	High	High
N/A	Short, dense	Medium	W/S	Medium	High
N/A	Medium, dense	Long	W/S	Medium	Low
N/A	Medium, upright	Medium	W	Medium	High
N/A	Short, dense	Short-lived perennial	S	High	Low
N/A	Short, dense	Perennial	W	High	Low
N/A	Short, dense	Medium - long	W	Medium	Excellent
N/A	Medium, dense	Short - medium	W	Medium	High
N/A	Medium, dense	Medium - long	W	Medium	High
N/A	Short-Medium, upright	Short - medium	W	Low	Moderate
N/A	Medium, upright	Short	S	Medium	Excellent
N/A	Short, upright	Long	W	Low	Excellent
N/A	Short, dense	Medium	S	Low	High
N/A	Tall, upright	Medium	S	Low	High
N/A	Short, dense	Short	S	Low	High

Ian Cunningham - Grabouw, Western Cape

Ian Cunningham holding a Barkant Fodder Turnip (summer type) on his farm, Fine Farms, in Grabouw. Grabouw is located in the Western Cape and predominantly receives winter rainfall therefore the results that he obtained under dryland conditions are remarkable.

Date of establishment: 5 September 2019
Date of photo: 3 December 2019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